The Effects of Spaceflight on Neurocognitive Performance: Extent, Longevity, & Neural Bases

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Background & Justification

- Spaceflight effects on gait, balance, & manual motor control have been well studied; some evidence for cognitive deficits
- Rodent cortical motor & sensory systems show neural structural alterations with spaceflight
- We found extensive changes in behavior, brain structure & brain function following 70 days of HDBR

Specific Aims

- Aim 1- Identify changes in brain structure, function, and network integrity as a function of spaceflight and characterize their time course.

- Aim 2- Specify relationships between structural and functional brain changes and performance and characterize their time course.

Evaluating neurocognitive changes occurring with spaceflight

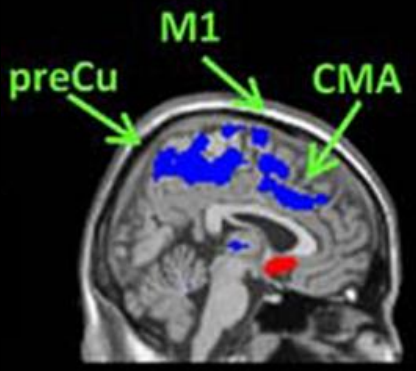
Testing timeline

L – 180 L - 60

R+ 2~4 R+30 R+90 R+180

FD30 FD90 FD150

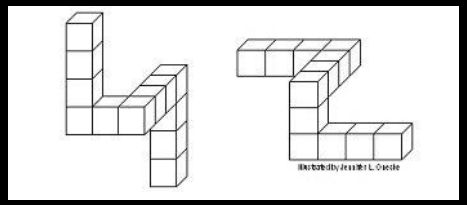
Assessments

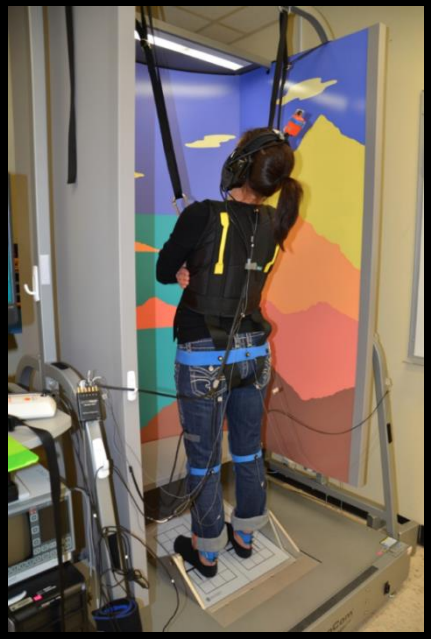


Structural MRI:
- Volumetric gray matter changes
- Diffusion weighted images

Functional MRI:
- Resting state functional connectivity of cognitive & motor networks
- Task based fMRI of motor, cognitive & sensory processing

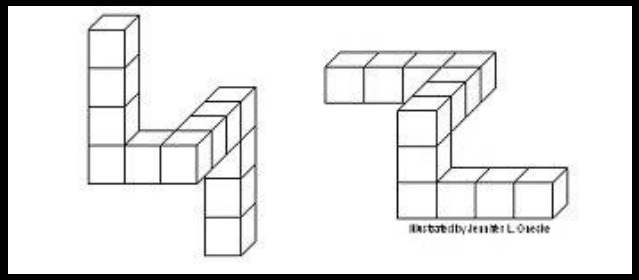
Additional Behavioral Metrics:
- Spatial cognition / working memory
- Manual motor control
- Vestibular evoked myogenic potentials
- Gait & balance (FMT, SOT)
- Sensory bias (rod & frame test)

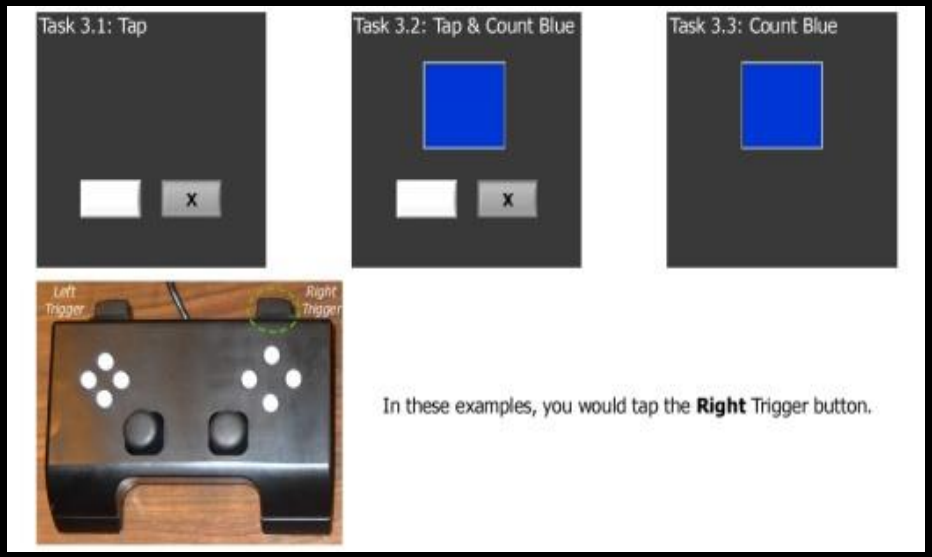




Inflight tests: behavior

- Sensorimotor adaptation
- Spatial cognition
- Cognitive-motor dual tasking

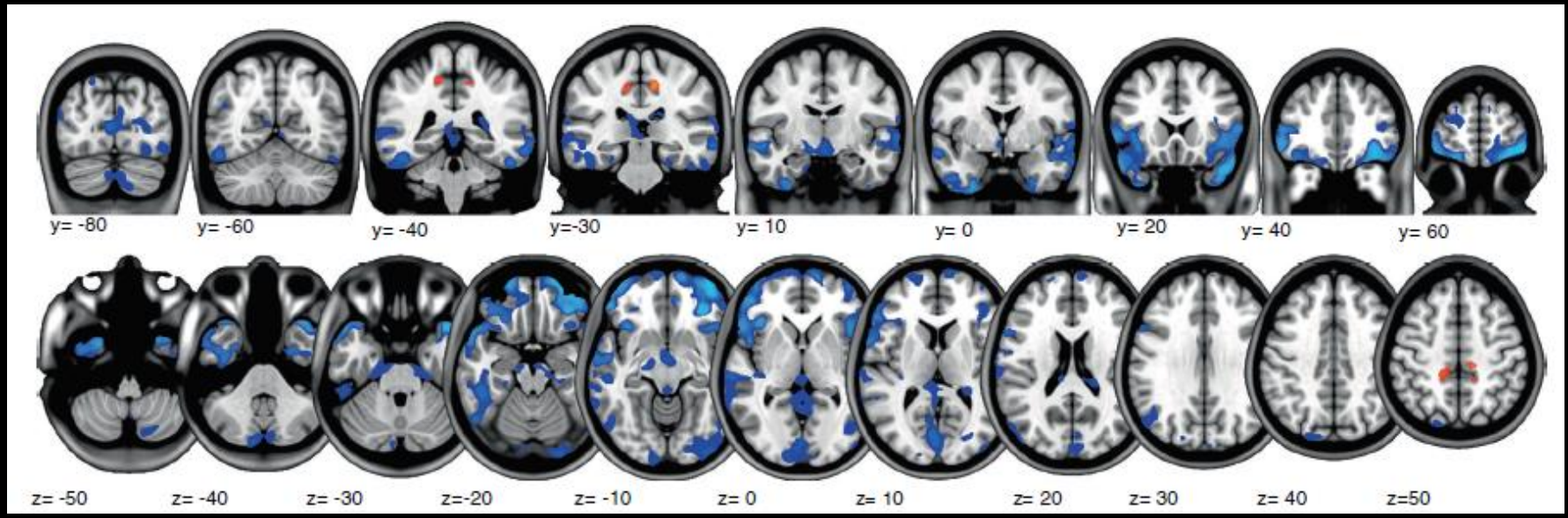




Progress Report

- 5 crew members have completed at least 1 post flight scan
- 1 additional 1 YRM crew member (presented yesterday)
- Bed rest version of the study is complete, several papers published:
  - Yuan et al. (2016) *Frontiers in Systems Neuroscience*
  - Cassady et al. (2016) *Neuroimage*
  - Koppelmans et al. (2015) *Frontiers in Systems Neuroscience*
  - Four others under review

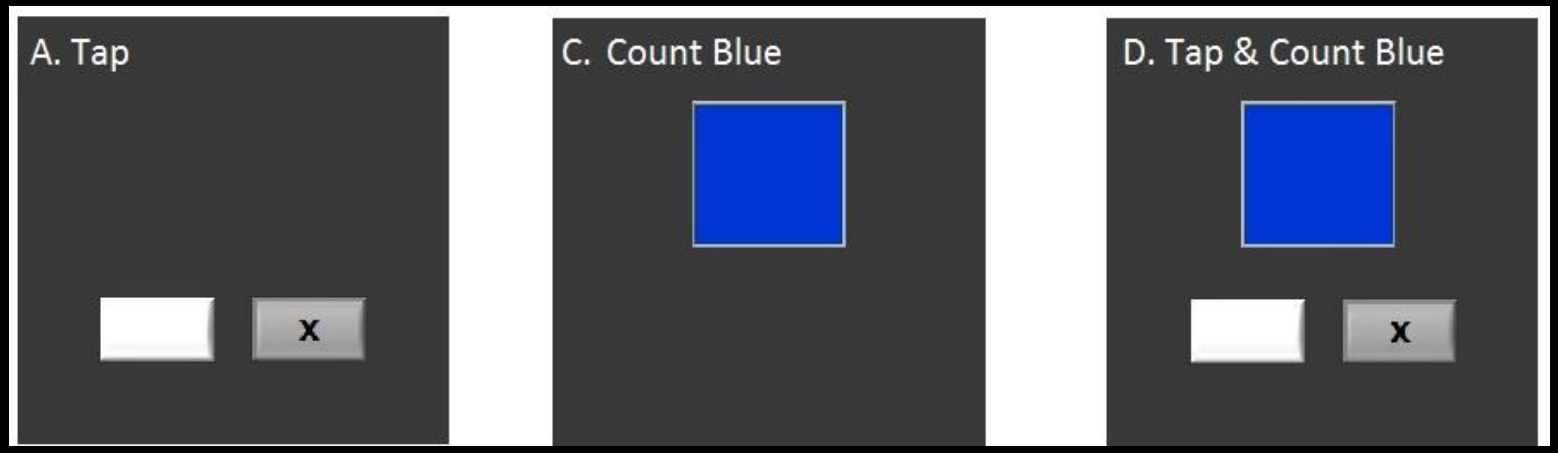
Retrospective study arm



Koppelmans V, Bloomberg J, Mulavara AP, & Seidler RD (in press). Brain structural plasticity with spaceflight. *npj Microgravity*.

Please note that activation results are overlaid onto a standard template brain for

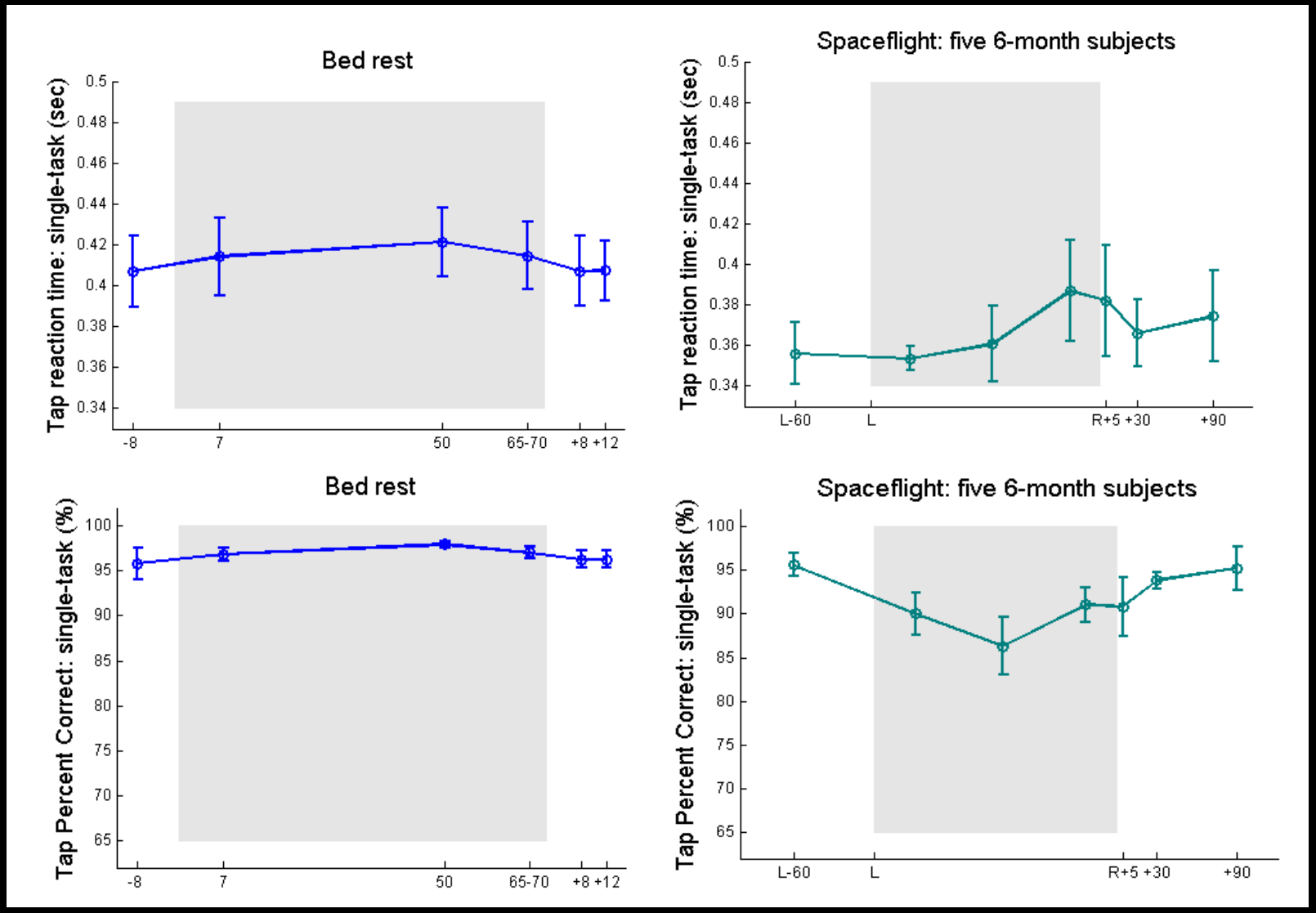
Single and dual tasking



RT and accuracy- single task

RT

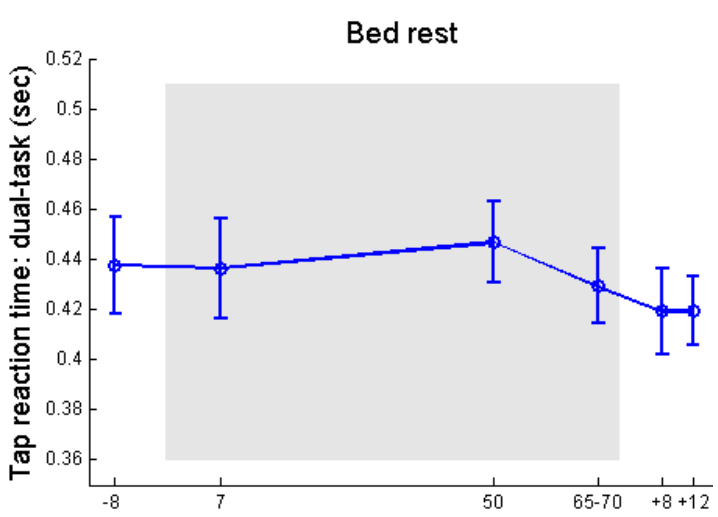
% correct

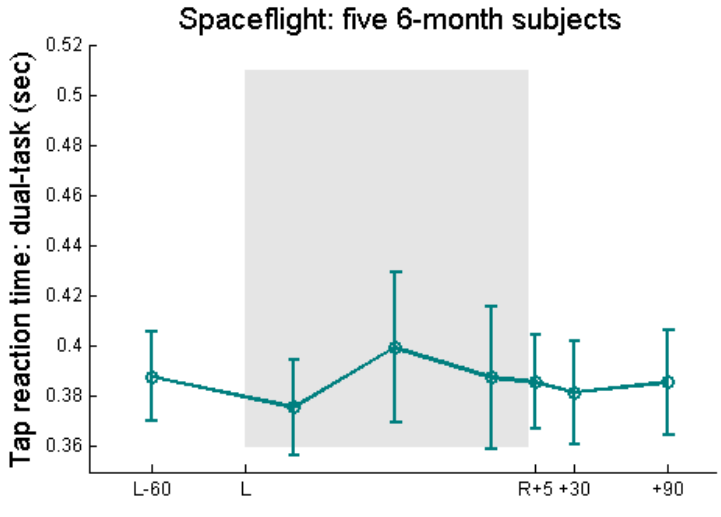


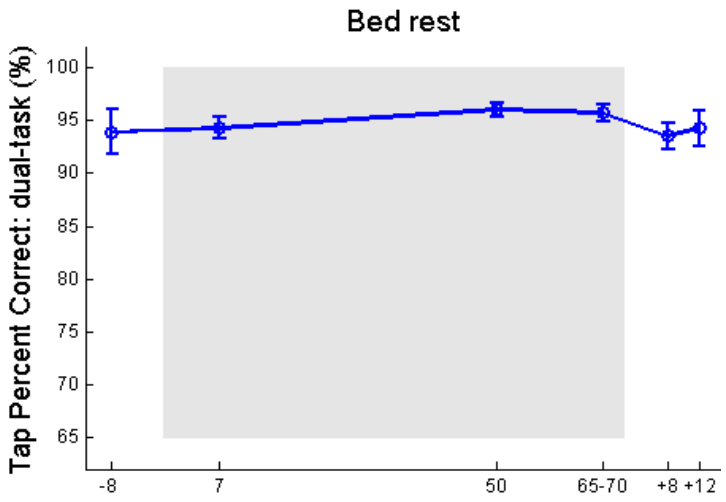
RT and accuracy- dual task

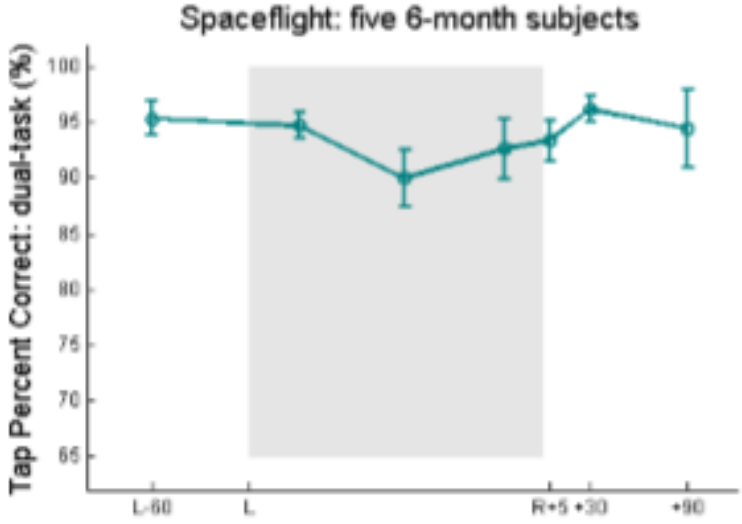
RT

% correct







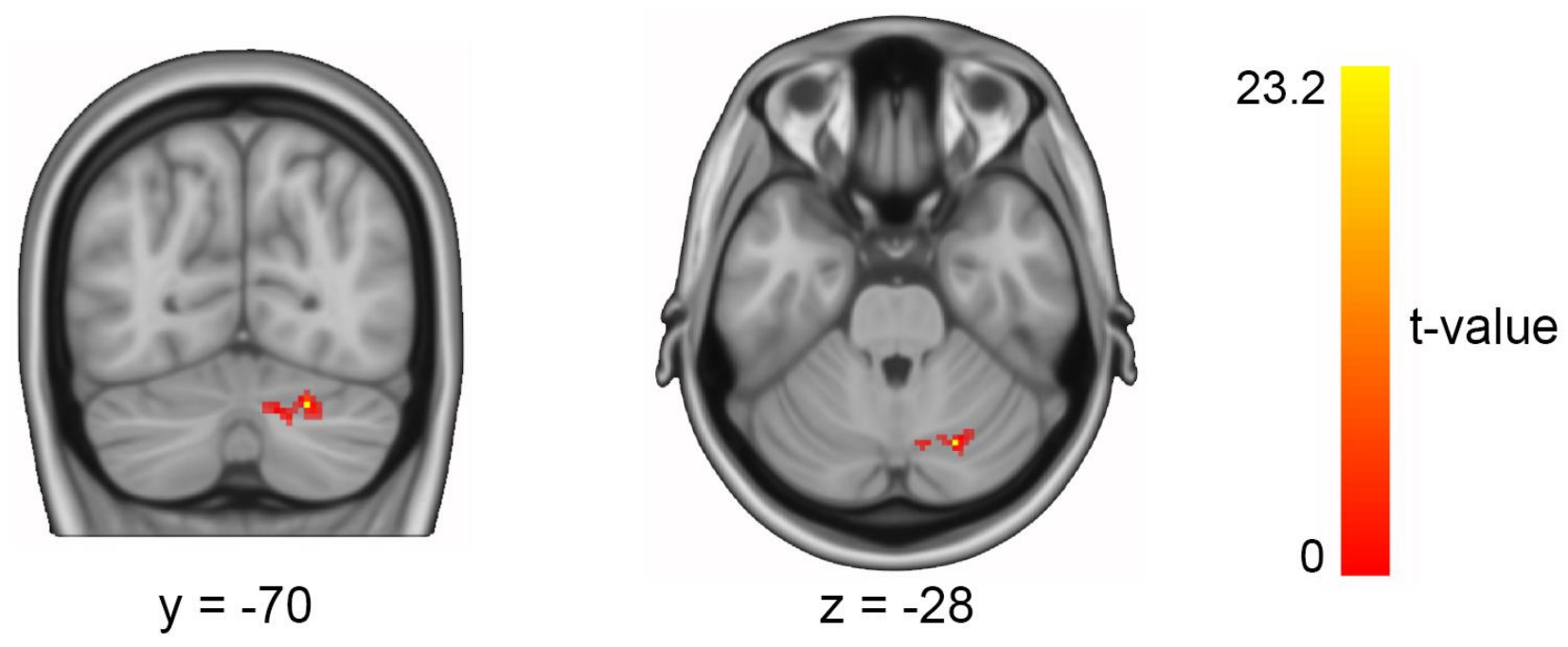


Dual tasking activates prefrontal cortex more post flight

Recruitment of the left middle frontal gyrus increases during dual tasking from pre to post flight

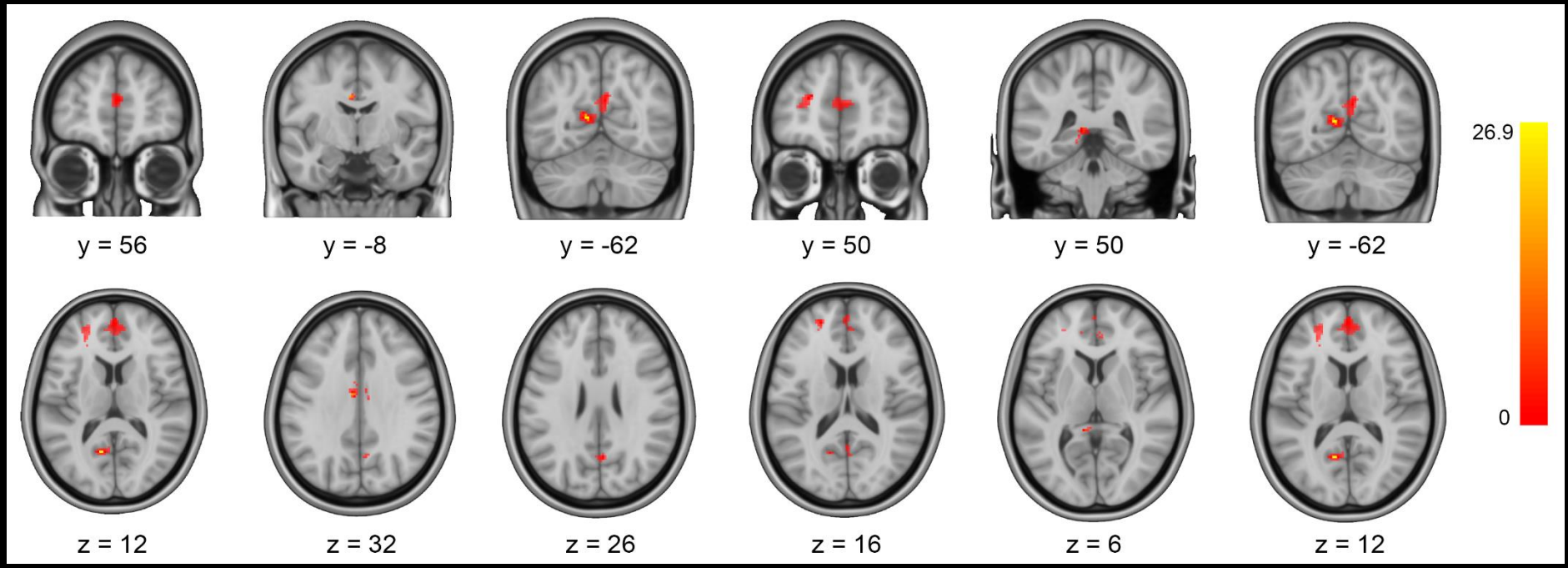
Please note that activation results are overlaid onto a standard template brain for

Increased intracerebellar connectivity lobule V with Crus I



Please note that activation results are overlaid onto a standard template brain for

Decoupling of the anterior & posterior portions of the default mode network



Please note that activation results are overlaid onto a standard template brain for

Summary

- Data collection is ongoing
- Results to date show cognitive, sensorimotor, and brain changes (I will show more sensorimotor data later this afternoon)

Want to see more?

- Talk today 17512
- Poster today 17420

Acknowledgements

- Sara Mason, LSAH
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